California Environmental Protection Agency

Air Resources Board

Installed Marine Fuel Tank Diurnal Venting Emissions Test Procedure

TP - 1503

Test Procedure for Determining Diurnal Vented Emissions From Installed Marine Fuel Tanks

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A set of definitions common to all Certification and Test Procedures is in Title 13, California Code of Regulations (CCR), Section 2752.

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative or designate.

1. APPLICABILITY

This Test Procedure, TP-1503, is used to determine the vented emissions from installed marine fuel tanks. This Test Procedure is proposed pursuant to section 43013 and 43018 of the California Health and Safety Code (CH&SC), and the references cited in section (9) of this document and is applicable in all cases where Pleasure Craft are sold, supplied, offered for sale, or manufactured for use in the State of California. . Pleasure Craft are defined as all trailerable spark-ignition marine vessels greater than 40 HP which include but are not limited to Personal Water Craft, In-Boards, In-Board Jet Drives, Stern Drives, and Outboards.

1.1 Requirement to Comply with All Other Applicable Codes and Regulations

Certification or approval of any evaporative emission control system by the Executive Officer does not exempt the engine or evaporative emission control systems from compliance with other applicable codes and regulations such as state and federal safety codes and regulations.

1.2 Safety

This test procedure involves the use of flammable materials and possibly hazardous operations and should only be conducted by, or under the supervision of, those familiar and experienced in the safe use of such materials and operations. Appropriate safety precautions should be observed at all times while performing the tests sequences in this test procedure.

2. PERFORMANCE STANDARDS

The minimum performance standards for certification of evaporative emission control

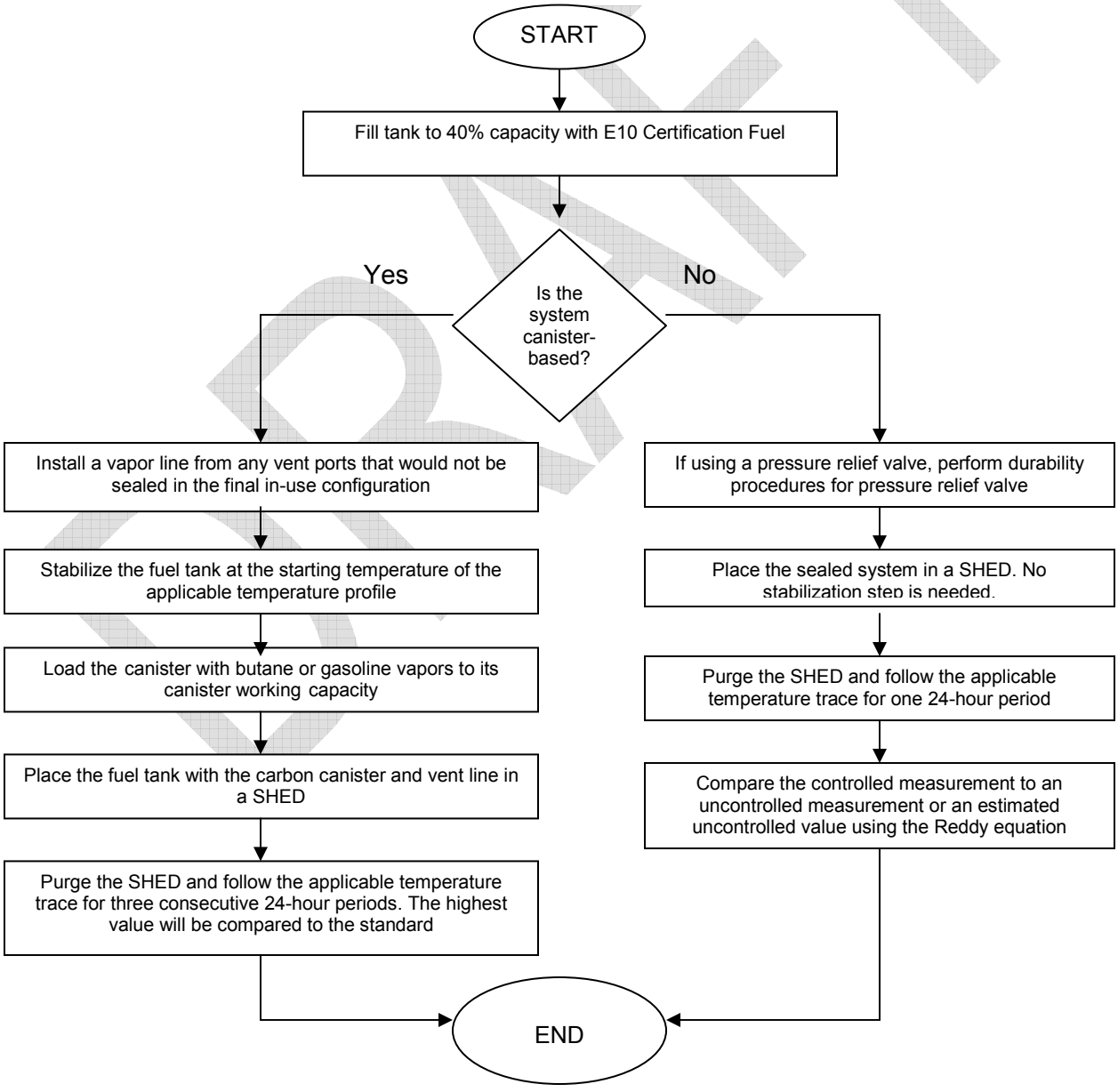
systems on Pleasure Craft is contained in CCR Title 13, Chapter 9, Article 4, section 2855.

3. GENERAL SUMMARY OF TEST PROCEDURE

The test sequence is shown graphically in Figure 1. All temperatures monitored during the test are tank fuel temperatures. The fuel tank shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

Testing a representative fuel tank for each evaporative family and comparing the results to the appropriate performance standard determines compliance with requirements of CCR Title 13, Chapter 15, Article 4, section 2855. The three day and one day diurnal test sequence is shown in Figure 1.

Figure 1.



4. INSTRUMENTATION

The instrumentation necessary to perform evaporative emission testing for pleasure craft engines is the same instrumentation used for passenger cars and light duty vehicles, and is described in 40 CFR 86.107-96.

4.1 Calibrations

Evaporative emission enclosure calibrations are specified in 40 CFR Section 86.117-90, as incorporated by reference. Amend 40 CFR section 86.117-90 to include an additional subsection 1.1, to read:

The diurnal evaporative emission measurement enclosure calibration consists of the following parts: initial and periodic determination of enclosure background emissions, initial determination of enclosure volume, and periodic hydrocarbon (HC) and ethanol retention check and calibration. Calibration for HC and ethanol may be conducted in the same test run or in sequential test runs.

4.2 Calculation of Hydrocarbon Mass

Calculate the final recovered hydrocarbon mass (M_{HC}) according to 40 CFR section 86.117-96(d)(1), as incorporated by reference.

5. TEST PROCEDURE

A Sealed Housing for Evaporative Determination (SHED) is used to measure diurnal emissions from installed marine fuel tanks. This method subjects installed marine fuel tanks to a fuel temperature profile while maintaining a constant pressure and continuously sampling for hydrocarbons with a Flame Ionization Detector (FID). The mass of total hydrocarbons from an evaporative control system over the test period is calculated using the ideal gas equation in 40 CFR section 86.117-96(d)(1).

This test procedure measures diurnal emissions from installed marine fuel tanks. The basic process is as follows:

(1) Diurnal measurements are based on a representative temperature cycle. For marine fuel tanks, the temperature cycle specifies fuel temperatures rather than ambient temperatures. The applicable temperature cycles are indicated in the following tables:

Table 3.1–Fuel Temperature Profile for Installed Marine Fuel Tanks in Trailerable Boats

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(°C)	25.6	25.7	26.5	27.9	29.2	30.4	31.4	32.0	32.2	32.2	32.1	31.7	31.0
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(°C)	30.2	29.3	28.6	28.0	27.5	27.0	26.6	26.3	26.1	25.9	25.7	25.6	--

Table 3.2–Fuel Temperature Profile for Installed Marine Fuel Tanks in Non-Trailerable Boats

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12
(^{o}C)	27.6	27.6	27.9	28.5	29.0	29.5	29.9	30.1	30.2	30.2	30.2	30.0	29.7
Hour	13	14	15	16	17	18	19	20	21	22	23	24	--
(^{o}C)	29.4	29.1	28.8	28.5	28.3	28.1	28.0	27.9	27.8	27.7	27.6	27.6	--

(2) Fill the fuel tank to 40 percent of nominal capacity with E10 Certification Fuel. A metal fuel tank of the approximate size and shape must be used during this test procedure to eliminate any permeation emissions.

(3) Install a vapor line from ports that would vent to atmosphere in the final in-use configuration. Use a length of vapor line representing the largest inside diameter and shortest length that would be expected for in-use installations of that tank.

(4) Stabilize the fuel tank at the starting temperature of the applicable temperature profile from paragraph (1) of this procedure. For sealed fuel systems, replace the fuel cap once the fuel reaches equilibrium at the appropriate starting temperature.

(5) If the fuel tank is equipped with a carbon canister, load the canister with butane or gasoline vapors to its *canister working capacity* as specified in 40 CFR §1060.240(e)(2)(i) and attach it to the fuel tank in a way that represents a typical in-use configuration. The canister is only certified for use on tanks of equal or lesser volume to the test tank used for certification

(6) Place the fuel tank with the carbon canister and vent line in a SHED meeting the specifications of 40 CFR 86.107–96(a)(1). Follow the applicable temperature trace from Table 3.1 or 3.2 of this procedure for a 24-hour period. You need not measure emissions during this stabilization step.

(7) As soon as possible after the stabilization in paragraph (6) of this section, purge the SHED and follow the applicable temperature trace from paragraph (1) of this procedure for three consecutive 24-hour periods. Start measuring emissions when you start the temperature profile. The end of the first, second, and third emission sampling periods must occur 1440 ± 6, 2880 ± 6, and 4320 ± 6 minutes respectively, after starting the measurement procedure. Use the average of the three 24-hour emission sampling periods to determine whether your fuel tank meets the diurnal emission standard.

(8) For emission control technologies that rely on a sealed fuel system utilizing a Pressure Relief Valve (PRV), you may omit the stabilization step in paragraph (6) of this procedure and the last two 24-hour periods of emission measurements in paragraph (7) of this procedure. The PRV must meet the requirements of Table 3.3 Pressure Relief Valve Durability and Reliability prior to conducting the SHED test. Purge the SHED and follow the applicable temperature trace from paragraph (1) of this procedure for one 24-hour period. The end of this 24-hour sampling period must occur at 1440 ± 6 minutes. This 24-hour sampling period emissions must meet the venting control efficiency standard of 65%. To determine the venting control efficiency, a venting control test must be conducted according

to TP-1503 with E10 Certification Fuel and then compared to the average emission value derived from the Diurnal SHED test results. As an alternative; an estimated uncontrolled venting value derived from the fuel tank vapor generation equation in SAE Technical Paper 892089, Prediction of Fuel Vapor Generation From a Vehicle Fuel Tank as a function of Fuel RVP and Temperature (Reddy, 1989) can be compared to the Diurnal SHED test results.

Table 3.3 – Pressure Relief Valve Durability and Reliability Requirements

Test Name	Test Conditions
Thermal Cycle	80ºC, 1.5 hours followed by 25ºC, 0.5 hours followed by -40ºC, 7.5 hours followed by 25º C, 0.5 hours followed by 50ºC, 95% humidity, 15.5 hours followed by 25ºC, 0.5 hours followed by -40ºC, 7.5 hours and followed by 25ºC, 0.5 hours is one cycle. Ten (10) cycles in total
Repetition at High Temperature	Repeated 7.35kPa and -2.94kPa at 80ºC is one cycle One million (1,000,000) cycles in total
Repetition at Low Temperature	Repeated 7.35kPa and -2.94kPa at -40ºC is one cycle One million (1,000,000) cycles in total
Vibration	59.8m/sec^2, 11Hz to each axis One million (1,000,000) cycles in total
Dust	Test room filled by dust indicated by JIS (Japanese Industrial Standards) type 15, 30g/m^3, repeated at 7.35kPa and -2.94kPa is one cycle Seventy-Three hundred (7,300) cycles in total.

6. TEST FUEL

E10 Certification Fuel: defined as the interim E10 CERT fuel until the adoption date of a California E10 certification fuel. The interim E10 certification fuel can continue to be used until one year after the adoption of a Californian E10 certification fuel.

Table 6.1 – Interim E10 Fuel Specifications

Fuel Property	Upper Limit
RVP	6.95 psi
T50	214 °F
T90	312 °F
Total Aromatic Hydrocarbons	24 vol. %
Olefins	7.4 vol. %
Total Oxygen	3.5
Sulfur	8 ppm by wt.
Benzene	0.74 vol. %
Ethanol	10 vol. %

7. ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the Executive Officer. In order to secure the ARB Executive Officer's

approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

8. REFERENCES

1. California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2000.

2. California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, California Environmental Protection Agency, Air Resources Board, El Monte, CA, 2002.

3. 40 CFR Part 86

4. SAE Technical Paper 892089, Prediction of Fuel Vapor Generation From a Vehicle Fuel Tank as a function of Fuel RVP and Temperature (Reddy, 1989).